PATENT COOPERATION TREATY

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

From the INTERNATIONAL BUREAU

To:

Commissioner
US Department of Commerce
United States Patent and Trademark
Office, PCT
2011 South Clark Place Room
CP2/5C24
Arlington, VA 22202
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 14 November 2000 (14.11.00)	
International application No. PCT/NZ00/00029	Applicant's or agent's file reference P418009 ALC
International filing date (day/month/year) 16 March 2000 (16.03.00)	Priority date (day/month/year) 16 March 1999 (16.03.99)

Applicant

ASHWORTH, William, Frederick

1. The designated Office is hereby notified of its election made:

   [X] in the demand filed with the International Preliminary Examining Authority on:

   12 October 2000 (12.10.00)

   [ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

   [ ] was not

   made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Claudio Borton
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38

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PATENT COOPERATION TREATY

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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

14

Applicant's or agent's file reference P418009 ALC	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/NZ00/00029	International filing date *(day/month/year)* 16/03/2000	Priority date *(day/month/year)* 16/03/1999

International Patent Classification (IPC) or national classification and IPC
H04N1/52

Applicant

MEGADOT SYSTEMS LIMITED et al.

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 7 sheets, including this cover sheet.

   ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

   I   ☒ Basis of the report

   II   ☐ Priority

   III   ☒ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

   IV   ☐ Lack of unity of invention

   V   ☐ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations suporting such statement

   VI   ☐ Certain documents cited

   VII   ☐ Certain defects in the international application

   VIII   ☒ Certain observations on the international application

Date of submission of the demand 12/10/2000	Date of completion of this report 15.03.2001
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Luckett, P Telephone No. +49 89 2399 8965

I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).):*
   Description, pages:

   1-12   as originally filed

   Claims, No.:

   1-21   as originally filed

   Drawings, sheets:

   1/14-14/14   as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐   the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐   the language of publication of the international application (under Rule 48.3(b)).

   ☐   the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐   contained in the international application in written form.

   ☐   filed together with the international application in computer readable form.

   ☐   furnished subsequently to this Authority in written form.

   ☐   furnished subsequently to this Authority in computer readable form.

   ☐   The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐   The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐   the description,   pages:
   ☐   the claims,   Nos.:

☐ the drawings,   sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

III. Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1. The questions whether the claimed invention appears to be novel, to involve an inventive step (to be non-obvious), or to be industrially applicable have not been examined in respect of:

☐ the entire international application.

☒ claims Nos. 1-21.

because:

☐ the said international application, or the said claims Nos. relate to the following subject matter which does not require an international preliminary examination (*specify*):

☒ the description, claims or drawings (*indicate particular elements below*) or said claims Nos. 1-21 are so unclear that no meaningful opinion could be formed (*specify*):
see separate sheet

☐ the claims, or said claims Nos. are so inadequately supported by the description that no meaningful opinion could be formed.

☐ no international search report has been established for the said claims Nos. .

2. A meaningful international preliminary examination report cannot be carried out due to the failure of the nucleotide and/or amino acid sequence listing to comply with the standard provided for in Annex C of the Administrative Instructions:

☐ the written form has not been furnished or does not comply with the standard.
☐ the computer readable form has not been furnished or does not comply with the standard.

VIII. Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:
see separate sheet

Introduction

The supporting arguments in the letter of reply dated 26.2.2001, do not lead to a different appreciation of the claims' clarity. These arguments are rendered spurious by the fact that they rely upon a detailed understanding of the embodiments set out in the description. The arguments overlook the extremely broad and vague terms of the several independent claims and fail to address the inconsistencies in terminology used therebetween. The arguments also do not broach the fact that the common subject matter of the independent claims is not defined in any clear technical context to the extent that it is not at present apparent that they: a) demonstrate the requisite industrial applicability; or b) even concern a single inventive concept.

Re Item III
Non-establishment of opinion with regard to novelty, inventive step and industrial applicability

1   The features of the independent claims are cast in such broad and vague terms that these claims are not deemed to find adequate technical support in the description nor to be adequately clear to enable a fair determination of their intended scope (Art 6, PCT).

2   The claims are neither clear nor concise (Art 6, PCT). The number of independent claims and the disparity between their respective subject matter makes it impossible to determine the matter for which protection is sought, and places an undue burden on others seeking to establish the extent of the protection. In order to overcome this objection, it would appear appropriate to file an amended set of claims defining the relevant subject-matter in terms of a minimum number of independent claims in each category followed by dependent claims covering features which are merely optional.

Re Item VIII
Certain observations on the international application

3a   In as far as their scope can at present be determined, it appears that at least
     some of the broader claims are either anticipated or rendered obvious by the
     disclosure of :-

D1:   GB-A-1 355 540 (HELL RUDOLF DR ING GMBH) 5 June 1974 (1974-06-05)
D2:   US-A-5 455 682 (IKUTA KUNIO) 3 October 1995 (1995-10-03)

D1 discloses multiple screen assemblies - for electro-optical reproduction of half-
tone images in which electro-optical reproduction of screen half-tone images uses
screen elements corresponding to a scale of tone values, each formed with a
coating corresp. to each such tone value, the relative widths and angles of the
screen lines are aligned w.r.t. the original so that the corner points of rectangular
modules or parcels of congruent structure result from bringing together points of
intersection of the composite screen and so that these parcels themselves, or
those rectangular parcel elements resulting from their subdivision, are scanned for
reproduction.

D2 discloses a method of and apparatus for recording halftone images deriving a
set of improved halftone images which effectively prevents occurrence of rosette
moire. A plurality of parallelograms can be formed from three apexes consisting of
an arbitrary first apex of a reference triangle RT1, a middle point of the side of the
triangle facing to the first apex, and one of the other two apexes of the triangle.
One of the parallelograms is selected as a unit area for one halftone dot. The unit
area is virtually laid out repeatedly on an image plane, and one halftone dot is
located with respect to each unit area. Each halftone dot can be located at the
center of the unit area or at any desirable position in the unit (attention is
particularly directed to D2 figure 5, and figure 17b which discloses a non-
orthogonal screen for each individual colour and colour dot growth which expands
"first ... along directions other than those of their closest spacing" - cf the
extremely broad terms of e.g. present claim 13)

3b   Both of these disclosures read on to the extremely broad terms of the
     independent claims. It is noted that in the claims, references to "non-orthogonal"
     screens do not clearly distinguish (Art 6, PCT) between two distinct cases:

I) The first is when plural screens, one for each colour e.g. CYMK, are each orthogonal in themselves but given respective rotation angles so that they are "non-orthogonal" between each other (the case in D1): and

II) The second is where each individual screen is itself a "non-orthogonal" screen (the case in D2).

3c Screen configurations of both kinds belong to a skilled persons' common knowledge in this technical field. Clarification in the claims, while necessary, will nonetheless be insufficient to bring out the inventive nub underlying the present application. This will require more detailed definition of the respective halftone pixel growth modus and its precise relationship to the respective colour screen geometry as well as the relationship between the respectively juxtaposed screens for each colour and the mutual juxtaposition of the growth directions of the different colour dots.

4   It is not at present apparent which part of the application could serve as a basis for a new claim.

5   The independent claim/s/ are not cast in the two part form, with those features which in combination are part of the prior art (see document D1) being placed in the preamble. This is considered to be **particularly appropriate** in the present case as it is regarded as **essential to establishing a clear picture** of the contribution made by the applicants vis-a-vis the closely relevant subject matter known from D1.

6   Reference signs in parentheses inserted in the claims would increase their intelligibility. This applies to both the preamble and characterising portion. It is also necessary to enhance the embodiments described, by use of more reference numerals in the description and drawings. These extra reference numerals, if used also in the various independent claims, can be expected to assist in understanding the ultimately adopted definitions of the invention where setting out: the "non-orthogonal" "screen" and/or "pattern" elements variously and ambiguously referred to therein; the so called "parcels"; the "printing areas"; the so called "meshes", "minimum mesh"; ... etc

7   Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in the document D1 is not mentioned in the description, nor is this document identified therein. To reflect the state of the art adequately in the description, the document D1 should be identified in the opening pages and the relevant background art disclosed therein should be briefly discussed.

9   Claims of the so-called "omnibus" type (i.e. claims 20 & 21) are excluded under the jurisdiction of some national and/or regional Intellectual Property authorities (e.g. The EPO).

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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

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(54) Title: IMPROVEMENTS RELATING TO HALFTONE PATTERNS

(57) Abstract

The patterns can be used to reduce one or more undesirable effects such as moire or colour shift in coloured halftone images. Colour screens in the images are based on a combination of non–orthogonal mesh structures with parcels of printing dots which have common shape and size. Preferably the dots grow in mid tones by extending first towards their second, third or fourth nearest neighbours.

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IMPROVEMENTS RELATING TO HALFTONE PATTERNS

FIELD OF THE INVENTION

5   This invention relates to halftone printing processes and in particular to patterns of printing areas which may be used for preparing coloured images. These patterns include arrangements of the printing and non-printing areas which reduce the occurrence of moire and other effects in an image.

10   BACKGROUND TO THE INVENTION

Halftone processes suffer a number of problems including moire effects and colour shift. Production of images using these processes involves a compromise between the perceptible impact of different undesirable effects. Reference is made to US

15   5,680,222 from the present inventor, and also to *Colour Screening Technology: A Tutorial on the Basic Issues*, The Seybold Report on Desktop Publishing, Vol 6, No.3, October 1991, for background information on these effects.

Moire includes both large and small scale effects due to periodic alignment of the

20   halftone dots on a set of screens which are used to represent different colours and black. The colours are typically determined by the CMYK (cyan, magenta, yellow, black) system although various other separation systems are also used. Spurious moire patterns including lines and rosettes have frustrated printers for many years as indicated in the Seybold article mentioned above. Methods have been proposed

25   to reduce these effects with varying degrees of success in varying circumstances.

Colour shift occurs when the dots of different colour separations or black overlap more or less than intended due to mis-registration of their respective patterns. For example, cyan and magenta inks are relatively intense in relation to yellow ink, and

30   an increased overlap of the microscopic printing areas of one or other intense ink on yellow ink can reduce the intended visual impact of the yellow. A slight displacement of the halftone patterns, for example, or stretching of the medium on which the coloured image is eventually printed, can create an overlap and cause an inaccurate reproduction of the original colours.

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Traditional halftone patterns or screens are generally Aorthogonal@ in that the printing areas are arranged in lines on a square or rectangular mesh . The Aprinting areas@ are dots in light tones which link in various ways to become extended regions in darker tones. A Ascreen@ is formed for each of the respective colours or black in

5   a selected colour system, and generally constitutes digital data for a computer-based process. Different screens may take a similar format but with different spacing between the lines of the mesh and a different angle of the lines from horizontal.

SUMMARY OF THE INVENTION

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It is an object of the present invention to provide patterns which can be used to reduce one or more of the undesirable colour related effects in halftone images. Accordingly the invention may broadly be said to consist in a combination of non-orthogonal patterns with common parcels of printing areas amongst at least some of

15   the patterns.

In one aspect the invention may be said to consist in a screen system for use in production of a coloured halftone image, wherein: a plurality of screens each represent different colours or black in the image, each screen has a pattern of

20   printing areas which defines a minimum mesh, each pattern has a parcel of printing areas which repeats throughout the respective screen, and two or more of the screens have different non-orthogonal minimum meshes and have parcels which correspond in shape and size.

25   In another aspect the invention may be said to consist in a method of preparing halftone patterns for production of a coloured image, comprising: receiving information representing colour and tone variation in an image, creating a plurality of printing patterns which represent different colours or black in the image, forming each pattern from variable printing areas which define respective meshes and

30   repeating parcels, at least two of the patterns having different non-orthogonal minimum meshes and corresponding parcels which are substantially similar in shape and size.

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Preferably each minimum mesh is formed by two sets of parallel lines which lie along directions defined by equal shortest or shortest and next shortest distances between the printing areas.

5   BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will be described with respect to the drawings, of which:

Figure 1 is a schematic diagram indicating a combination of computer-based 10 systems by which halftone processes may be implemented,

Figure 2 is a flowchart indicating general processes in which a halftone image may be produced by scanning a recorded image,

Figure 3 is a flowchart indicating general processes by which a halftone image may be produced by generating an image initially on a desktop computer 15 system,

Figure 4 is a flowchart indicating a general process for generating halftone screens from image data in Figure 2 or 3,

Figures 5a to 5d are four halftone patterns having a common tone density and different arrangements of printing areas,

20   Figures 6a to 6d are the four halftone patterns with each defining a non-orthogonal mesh over the printing areas,

Figures 7a to 7d are the four patterns with each defining a non-orthogonal mesh and a repeating parcel of printing areas,

Figures 8a to 8d are an alternative set of four patterns with each defining a 25 non-orthogonal mesh and a repeating parcel of printing areas, by way of further example,

Figures 9a and 9b are combined patterns for Figures 6a, 6c and 6b, 6d respectively,

Figures 10a to 10d are the four patterns of Figures 5a to 5d with extended 30 printing areas creating a darker tone,

Figures 11a and 11b are combined patterns and meshes for Figures 10a, 10c and 10b, 10d respectively,

Figure 12 demonstrates the combined patterns and meshes of Figures 9a and 9b,

35   Figure 13 demonstrates the combined patterns of Figures 11a and 11b,

Figures 14a, 14b, 14c, 14d demonstrate preferred growth patterns for dots in a few selected cases,

Figures 15 and 16 are halftone cells which might be used in creating non-orthogonal halftone patterns according to the invention, and

5   Figure 17 is a simplified threshold matrix for further explanation of the processes and cells of Figures 4 and 15.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

10   Referring to the drawings it will be appreciated that the various novel patterns must here be printed in black and white, and magnified by up to perhaps 1000x for the purposes of a clear description. It is not possible to demonstrate their full advantage under these circumstances. Also that the patterns and various shapes of the printing and non-printing areas may be implemented by an appropriate mathematical

15   construction of a spot function or a threshold matrix, using a wide range of hardware and software which are already available. a schematic indication of hardware and software systems which are suitable for implementing the invention will be given, but details are left to the skilled reader, with direction to the references given above.

20   Figure 1 indicates a highly schematic collection of computer-based or otherwise computer controlled equipment which might be used in production of halftone patterns and images, and in producing a result in printed form. a wide range of equipment and software is currently in use or under development and these items are shown by way of example only, for the purposes of explanation. That part of the

25   processing which relates most closely to the invention usually takes place in a computer processor arrangement 10, which may be a separate item of equipment as indicated, or part of a more general item such as a desktop computer 12. This item generally has a main processor 18 and data storage capacity 17, and may also have a dedicated processor 19 for high speed processing of image data. Halftone patterns

30   or screens 11 produced by the processor are indicated as physical forms 11 in the CMYK system, which might be film from an imagesetter or laser plotter 15 for example, or printing plates for a press 16. Alternatively the screens may be represented by computer data in a memory storage component such as a magnetic disk. An original image may be input to the equipment in various ways, such as

35   from a photograph or other tangible artwork scanned by a digital scanner 14.

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Alternatively the original image may be created initially on a computer system such as a personal computer terminal 12, perhaps part of a desktop publishing system including a printer 13.

5   One traditional process for preparing a halftone image is outlined in Figure 2. An original image is recorded in step 20, as a photograph for example, and scanned in step 21. The resulting digital information is stored as pixel-based colour and intensity data. Pixels are square or rectangular elements generally aligned with vertical and horizontal directions of reference such as the directions of scanner

10   movement. The pixel information is then processed into a standard format such as POSTSCRIPT in step 22. a wide variety of patterns and processes are then available for conversion of the pixel data to halftone screen data, and details appropriate to a particular image are selected by an operator in step 23. The conversion processes take place in step 24 by way of a computer system 10 such as that indicated in Figure

15   1. The patterns are generally created from the pixel information by a raster image processing program or RIP, which calculates the locations, spacings and shapes of the halftone printing areas for each colour separation. An operator normally has a range of standard patterns installed on the equipment and may be able to develop variations of these patterns in some cases. Traditional calculations involve screen

20   frequencies and angles although more sophisticated equipment enables patterns to be created without reference to these parameters. The operator is able to proof and modify the selection of patterns to minimise various effects such as moire, colour shift and tone jump according to the subsequent reproduction technique.

25   In Figure 2, a coloured image based on the halftone data can be output in various ways, depending on the manner in which the image will be published and the equipment which is available. The patterns may be produced on film in step 25 and tested as proofs in step 26 which are inspected for defects such as moire. However, alternative halftone patterns and processes may be selected in step 23. If the proofs

30   are acceptable, printing plates such as used in offset printing may be created in step 27 to enable a print run in step 28. Sometimes the plates are produced directly from the halftone data, as indicated. In other processes such as desktop publishing an image combining the patterns may be output directly without plates through a laser printer or other printing device, as also indicated. Details of each of the various

items of equipment which might be used in these processes, such as those indicated in Figure 1, are beyond the scope of this specification.

5   Figure 3 outlines an alternative and more direct process for generating and printing halftone images. An original digital image is created in step 30 on a computer device. The image data may be created using a graphics program and stored in a format which is native to the device, such as a particular vector or bitmap format for example. Parts of the image may also be imported from other sources such as clipart or scanned photographs, when composing a desktop publication for example. In step

10   31 the native data is converted into a standard format such as POSTSCRIPT which can be interpreted by an output device, such as local laser printer with a particular resolution. The pixel data must generally be converted in step 32 into a form which is appropriate for the particular printer. a device such as a laser printer uses a grid for placement of coloured ink spots and the pixel data is generally rastered to match

15   this grid. a halftone pattern is selected either automatically or by an operator in step 33. a RIP or similar software then converts the pixel data into halftone data in step 34 which is stored in computer memory as part of the POSTSCRIPT information. Copies of the original image may then be printed in step 35 or transferred elsewhere from the stored data as required.

20

Figure 4 outlines the conversion process of steps 24 and 34, as generally carried out by known RIP software. The process first receives pixel data including colour and tone information in step 40. Each pixel includes data which enables determination of a tone value for each of the colours in a chosen colour system, usually CMYK,

25   for a small area located at the point represented by the pixel in the coloured image. The generation of a halftone screen for each of the colours produces a large amount of data that may be stored in a common computer file or in separate files. This data usually takes the form of binary on/off instructions in relation to the output grid of a printing device. In steps 41 through 44 the pixel data is parsed for each of the

30   required colours to determine halftone screen data for that colour. Mathematical constructs called spot functions or threshold matrices are used in step 42 to determine the halftone patterns which have been selected for the colours, as will be explained further below. Each pixel is compared with a threshold matrix for the particular colour and binary data relating to the output grid of the particular printing

35   device is determined and stored in an appropriate computer file in step 43.

Eventually the colour separation is complete and the halftone data can be stored or output to the printer device in step 45 when required.

5   Figures 5a, 5b, 5c, 5d show four halftone patterns which form parts of four different colour screens according to the invention. They should be considered as patterns viewed from horizontal with respect to an image, representing different colours or black in a general sense, without limitation to screen related parameters such as dot frequencies and angles. The patterns might represent cyan, magenta, yellow and black in a four colour image generated by way of a halftone process such as outlined

10   in Figure 4. The printing areas in each pattern are composed of conventionally shaped round dots which may grow in size and shape in various ways, and may join in darker tones, according to variations in tone across the particular image. Other dot shapes may also be used. a uniformly light tone is represented here by way of example, and a similar pattern of non-printing areas would preferably but not

15   necessarily appear in darker tones. It will be appreciated that a wide range of possible dot shapes and growths may be implemented in practice. It is primarily the relative arrangement of at least some of the patterns in a set of screens that make up an image which forms the subject of the invention.

20   Figures 6a, 6b, 6c, 6d show the patterns of Figures 5a, 5b, 5c, 5d each with a superimposed mesh formed by two sets of parallel lines which pass through the dots. The meshes are Anon-orthogonal@ in that the sets of lines intersect at other than right angles and are not perpendicular. Each mesh has a repeating unit which takes the shape of an oblique parallelogram such as a rhombus with four equal length sides

25   or a rhomboid with two pairs of different length sides. The meshes are also Aminimum@ in that the sides of each parallelogram are formed by the shortest or second shortest distances measured between the centres of the dots. The repeating unit may be either a rhombus with four shortest sides or a rhomboid with two shortest and two second shortest sides. a large number of meshes may be defined

30   for each pattern including both orthogonal and non-orthogonal lines. However, it is believed that any pattern can have only a single minimum mesh of this kind. The minimum mesh is not necessarily used in calculation of the pattern but will usually be defined by consideration of a finished arrangement of printing areas determined by some other process.

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Figures 7a, 7b, 7c, 7d show the patterns and meshes of Figures 6a, 6b, 6c, 6d each
with a further superimposed mesh of a different kind. These meshes are orthogonal
in this example, in that the two sets of parallel lines intersect at right angles, but may
also be non-orthogonal. Each mesh has a repeating unit or Aparcel@ of printing
5   areas which can take a more general range of parallelogram shapes including squares
as shown, or rectangles, rhombii, rhomboids and so on. Still other non-
parallelogram shapes which are able to repeat throughout a pattern may also be
considered. These meshes are clearly not minimum meshes in that their parcels
typically include a relatively large number of printing areas on each side, although
10 once again, a wide range of meshes having repeating parcels can be defined for a
particular pattern. It can be seen that the repeating parcels which are indicated in
each of these figures are substantially the same in size, shape and orientation for all
of the four patterns.

15 Figures 8a, 8b, 8c, 8d show four alternative halftone patterns which might also form
parts of four different colour screens according to the invention. Once again the
patterns each define an underlying non-orthogonal minimum mesh, and also another
mesh with repeating parcels which have a shape and size in common with at least
some of the other patterns. The parcels which are indicated in these figures will
20 coincide when the patterns are laid one on the other, although the particular meshes
need not have been drawn in this way. It is thought that the invention is best
performed when all of the screens which make up an image have a non-orthogonal
minimum mesh. Each minimum mesh is preferably but not necessarily different to
the others. Two meshes are regarded as different not only when the shapes of their
25 respective units are different, but also when the shapes are the same and the meshes
are simply rotated with respect to each other. The invention is also best performed
when all of the screens have a common repeating parcel of some kind. However, an
image in which a selection of two or more, rather than all of the screens meet these
requirements may also be visually acceptable.

30
Figures 9a and 9b demonstrate pairs of patterns in combination, by way of further
example, formed by superimposing the patterns of Figures 6a, 6c and 6b, 6d. They
could represent combinations of cyan, magenta and yellow, black. The visual aspect
of the combined patterns is somewhat deceptive in that the different colours have
35 different intensities when printed, with yellow being considerably less intense than

black. However, it will be seen that the printing areas in these patterns have been arranged in a way which reduces their overlap in light tones. The figures are also deceptive in that the combination of non-orthogonal meshes can be interpreted as two orthogonal meshes which the eye tends to favour. The arrangement has been
5   determined manually although a more rigorous computer based method might also be used. It is generally impossible to eliminate all overlap throughout an image because the printing areas will necessarily grow and overlap in darker tones, with corresponding shrinkage and fragmentation of the non-printing areas.

10   Figures 10a, 10b, 10c, 10d show the patterns of Figures 5a, 5b, 5c, 5d with preferred forms of dot growth in mid to darker tones. In general terms the printing areas of each pattern become oval or lenticular shapes which enlarge first in an initial direction as shown, and then in another. In each case however, the directions of growth are preferably towards nearby printing areas, and preferably but not
15   necessarily differ between the patterns of a particular image. The areas of each pattern therefore join in two distinct stages resulting from their growth in two different directions. This reduces the effects of tone jump caused by physical effects in the ink with which the patterns are eventually printed. The directions of growth preferably lie along the second and more preferably the third or fourth shortest
20   distances between printing areas as shown. The third and fourth shortest distances between printing areas are generally diagonals in the repeating unit of the minimum mesh. Growth along the longest diagonal between neighbouring areas in a repeating unit will often produce the best result. Growth along the shortest distance is generally along one of the sides of the repeating unit and can produce undesirable
25   line aspects in the image. The second shortest distance can be either a line or a diagonal depending on the particular mesh.

Figures 11a and 11b demonstrate pairs of patterns in combination showing their initial directions of growth in the printing areas. They are taken from the patterns
30   of Figures 10a, 10c and 10b, 10d respectively and could for example, represent combinations of cyan, magenta and yellow, black. For these particular combinations of colours the areas preferably, but as usual not necessarily, grow in perpendicular directions.

Figures 12 and 13 are provided as an attempt to demonstrate the nature of an image combining four patterns according to the invention. They are taken from the patterns of Figures 9a, 9b and 11a, 11b respectively. An illusion of orthogonal meshes exists as before. The absence of any significant moire effect is clearly seen although it is
5 impossible to indicate the absence of other colour effects. Reasonable mis-registration of the patterns has not been observed to cause any significant colour shift in these examples.

Figures 14a, 14b, 14c and 14d demonstrate preferred growth of printing areas in
10 light to mid tones and may be compared with Figures 10a, 10b, 10c and 10d. Figure 14a demonstrates growth along the third shortest distance between near neighbouring dots on a non-orthogonal minimum mesh. Given that the repeating unit of this mesh is a parallelogram with two equal sides this also demonstrates growth along the longest distance in a repeating unit, namely the longest diagonal.
15 Figure 14a directly matches Figure 10a and on rotation matches Figure 10c. Figure 14b demonstrates growth along the fourth shortest but again the longest distance between neighbouring dots. The repeating unit of the non-orthogonal mesh has unequal sides. It matches Figure 10b and on rotation Figure 10d. Figure 14c demonstrates growth along the second shortest distance for a repeat unit having two
20 equal sides, which is the shortest diagonal. Figure 14d demonstrates growth along the second shortest distance for a repeat unit having unequal sides, which is now the longest side rather than a diagonal. Dot growth considerations of this general kind are useful in orthogonal meshes also.

25 Figures 15 and 16 show typical Acells@ which might be used in relation to the process of Figure 4 to produce halftone patterns having non-orthogonal minimum meshes. These cells relate to the patterns which are shown in Figures 8a to 8d, by way of example. Larger cells could also be used such as the parcels themselves as shown in Figures 7a to 7d. Each cell corresponds to a relatively small group of
30 pixels in the image data received in step 40 of Figure 4. They contain whole and partial portions of printing areas, in the form of circular dots in this case which might be present in light tones of a halftone image. Dots which lie on the sides and corners of the cells are regarded as being shared with neighbouring cells so that there are effectively two and six dots respectively in Figures 15 and 16 The proportion of
35 printing to non-printing areas in each cell relates to the tone or intensity of the

- 11 -

particular colour at that point in the image. In practice the dots are composed of many smaller spots which are formed by an output device such as a laser printer, and would not have a perfectly circular periphery on close inspection. The halftone data which makes up an image primarily comprises instructions for generation of these
5   spots.

Figure 17 provides a simple example of a hypothetical threshold matrix for purposes of further explanation of the process in Figure 4. a matrix of this kind, although generally much more extensive, may be used to determine which of the spots in the
10   halftone cells of a particular colour screen are required when an image is output. The matrix for a particular colour determines the shape of the dots of that colour and how they change to represent different levels of intensity for the colour in the image. Each element in the matrix represents a printing spot in the output grid of a device such as a laser printer. The matrix in this example could be used to determine a cell
15   such as shown in Figure 15, although given the limited number of Aspots@ the dots would be far from the circular shape. Careful selection of the elements can be used to determine the overall pattern of printing areas in a screen and how the shape of the areas changes with tone. The content of the matrix may be prepared either manually or according to a formula, and then stored for lookup when converting an
20   image from pixel to halftone data. Alternatively the formula, sometimes called a spot function, could be used to calculate the content when required during the conversion process.

In Figure 17 the elements of a particular matrix are assigned threshold values for
25   comparison with the tone of the particular colour of the group of pixels which corresponds to each cell. The values are spread between a maximum tone in which every spot would print, and a minimum tone in which none of the spots would print. In this example, the maximum tone is represented by the value A35@ representing a uniformly dark cell, and the minimum tone by the value A0@ representing a
30   uniformly light cell. Suppose that this matrix had been created for the colour cyan, and for a particular cell somewhere in an image undergoing conversion from pixel data to halftone data, the tone for cyan was A5@. Only those spots having threshold values less than or equal to A5@ would be required to represent the relatively light tone at that point in the printed image. Halftone data for the cyan screen would be
35   stored for that cell indicating that only the centre and corner spots were required.

- 12 -

The content of the cell would approximately resemble that of Figure 15, except that the corner dots would be four times larger than the centre dots, given the effect of neighbouring cells. a tone value of A8@ would produce a central dot having four spots, in the shape of an inverted AT@, and so on for darker tones.

5

The explanation of a process for conversion of pixel data to halftone data is given by way of example only. Various processes may be used to create patterns according to the present invention. Threshold matrices used in these processes may be extensive. a square matrix having 92x92 elements has been used for the cyan screen in some tests. a rectangular matrix having 46x69 elements has been used for the black screen. The repeating parcel has been a square of 276x276 elements. Practical procedures are complex and varied as will be appreciated by a skilled reader.

10

CLAIMS:

1.   A screen system for use in production of a coloured halftone image, wherein:

a plurality of screens each represent different colours or black in the image,

each screen has a pattern of printing areas which defines a minimum mesh,

each pattern has a parcel of printing areas which repeats throughout the respective screen, and

two or more of the screens have different non-orthogonal minimum meshes and have parcels which correspond in shape and size.

2.   A system according to claim 1 wherein:

each minimum mesh is formed by two sets of parallel lines which lie along directions defined by equal shortest or shortest and next shortest distances between the printing areas.

3.   A system according to claim 2 wherein:

at least two of the minimum meshes are non-orthogonal in that the two sets of lines are not perpendicular.

4.   A system according to claim 1 wherein:

the parcels which correspond between the two or more screens have a parallelogram shape.

5.   A system according to claim 1 wherein:

the parcels which correspond between the two or more screens have a common orientation.

6.   A system according to claim 1 wherein:

the parcels are formed according to an orthogonal mesh.

7.   A system according to claim 1 wherein:

the printing areas in darker tones extend along next shortest or longer distances between the areas.

- 14 -

8. A method of preparing halftone patterns for production of a coloured image, comprising:

   receiving information representing colour and tone variation in an image,

   creating a plurality of printing patterns which represent different colours or

5 black in the image,

   forming each pattern from variable printing areas which define respective meshes and repeating parcels,

   at least two of the patterns having different non-orthogonal minimum meshes and corresponding parcels which are substantially similar in shape and size.

10

9. A method according to claim 8 wherein:

   the non-orthogonal meshes are each defined by two sets of parallel lines which intersect at non-right angles.

15 10. A method according to claim 8 wherein:

   the corresponding parcels are substantially similar in orientation.

11. A method according to claim 8 wherein:

   the patterns each have different arrangements of printing areas within their

20 respective parcels.

12. A method according to claim 8 further comprising:

   joining the printing areas in darker tones along directions of second shortest or longer distances between the areas.

25

13. A pattern for a halftone image, wherein:

   printing areas define a non-orthogonal minimum mesh and extend first with darkening tone along directions other than those of their closest spacing.

30 14. A pattern according to claim 13 wherein:

   the printing areas extend along the direction of second, third or fourth closest spacing.

15. A pattern according to claim 13 wherein:

35 the printing areas have an oval shape.

16. A screen system for use in production of a coloured halftone image, wherein:
a plurality of different screens each represent different colours or black in the image,
each screen has a pattern of printing areas which defines a minimum mesh,
5   the minimum meshes of at least two screens are non-orthogonal and have printing areas which extend to join first along directions other than that of their closest spacing.
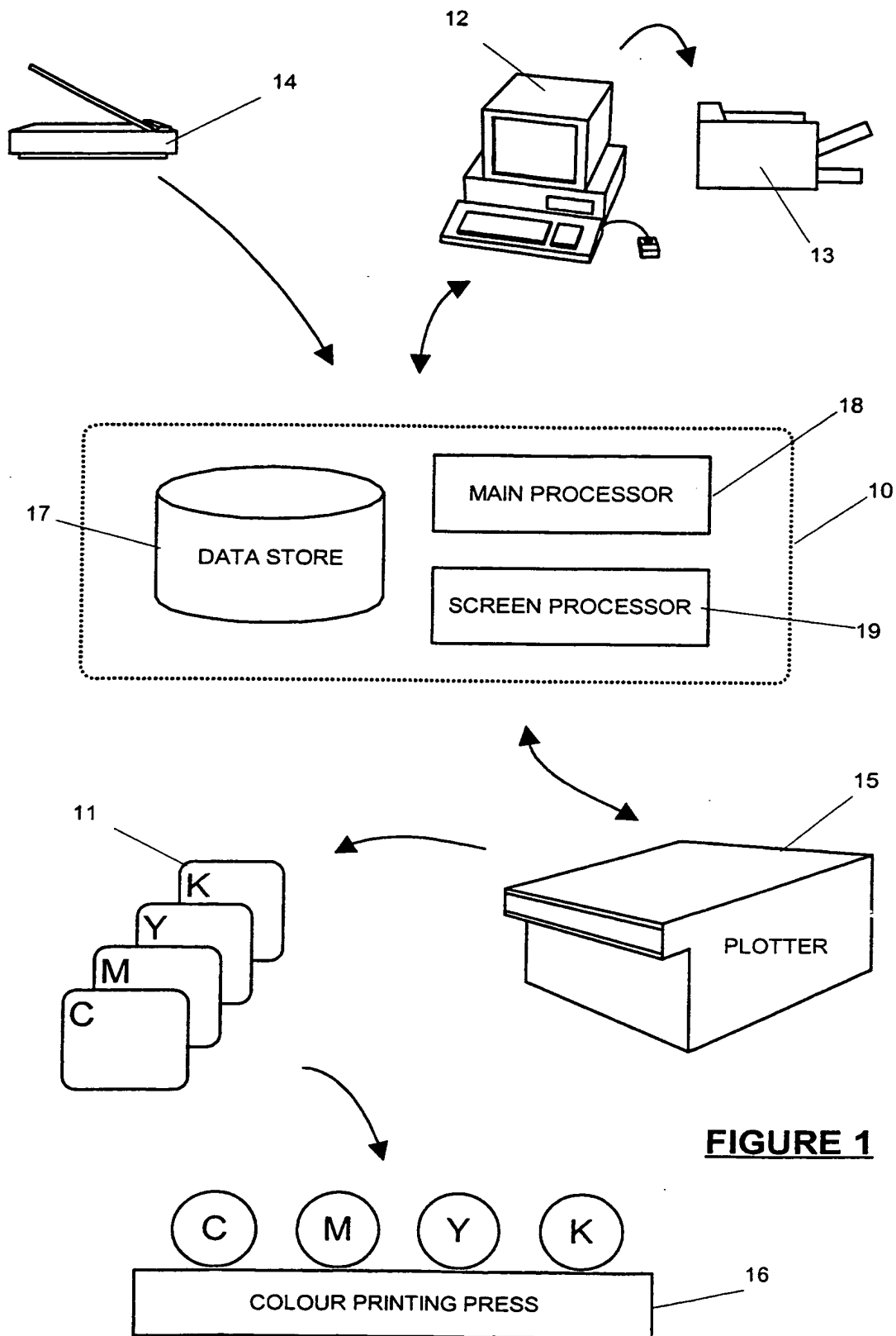
17. A screen system according to claim 16 wherein:
10   all of the screens have non-orthogonal meshes.

18. A method of preparing a halftone pattern, comprising:
receiving information representing tone variation in an image,
creating a pattern of printing areas which represents the variation by;
15   forming the pattern to define a non-orthogonal minimum mesh, and
varying the printing areas by extension toward nearby areas other than their nearest neighbours.

19. A method according to claim 18 further comprising:
20   extending the printing areas toward their second or third nearest neighbours.

20. Apparatus which implements a screen system or a method according to any one of the preceding claims.

25 21. A halftone image produced by a screen system, a method or an apparatus according to any one of the preceding claims.
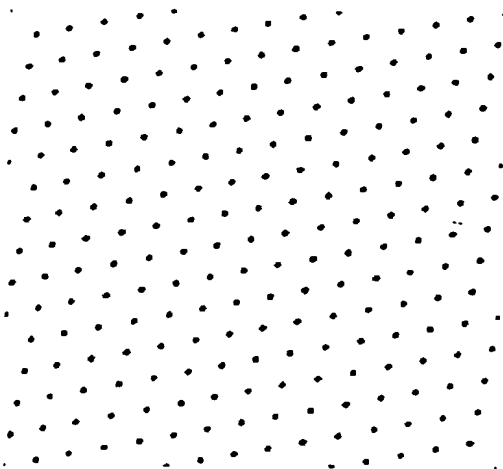
FIGURE 1

```
        ┌─────────────────┐
        │ RECORD ORIGINAL │──── 20
        │     IMAGE       │
        └─────────────────┘
                 │
                 ▼
        ┌─────────────────┐
        │  SCAN IMAGE TO  │──── 21
        │ PRODUCE PIXEL   │
        │     DATA        │
        └─────────────────┘
                 │
                 ▼
        ┌─────────────────┐
        │ CONVERT PIXEL   │──── 22
        │ DATA TO STANDARD│
        │    FORMAT       │
        └─────────────────┘
                 │
                 ▼
   23 ──┌─────────────────┐
        │ SELECT OR MODIFY│◄──────┐
        │ HALFTONE PATTERN│       │
        └─────────────────┘       │
                 │                 │
                 ▼                 │
        ┌─────────────────┐──── 24 │
        │ CONVERT PIXEL   │       │
        │ DATA TO HALFTONE│       │
        │     DATA        │       │
        └─────────────────┘       │
                 │                 │
                 ▼                 │
        ┌─────────────────┐──── 25 │
        │ OUTPUT PATTERNS │       │
        │    ON FILM      │       │
        └─────────────────┘       │
                 │                 │
  26 ──           ▼                 │
        ┌─────────────────┐       │
        │  PREPARE PROOFS │───────┘
        └─────────────────┘
                 │
                 ▼
        ┌─────────────────┐──── 27
        │ PRODUCE PRINTING│
        │     PLATES      │
        └─────────────────┘
                 │
                 ▼
        ┌─────────────────┐──── 28
        │ PRINT COPIES OF │
        │     IMAGE       │
        └─────────────────┘
```

FIGURE 2

```
        ┌─────────────────┐
        │ GENERATE IMAGE  │──── 30
        │ DATA IN NATIVE  │
        │     FORMAT      │
        └─────────────────┘
                 │
                 ▼
        ┌─────────────────┐──── 31
        │ CONVERT NATIVE  │
        │ DATA TO STANDARD│
        │     FORMAT      │
        └─────────────────┘
                 │
                 ▼
        ┌─────────────────┐──── 32
        │ CONVERT PIXEL   │
        │ DATA FOR OUTPUT │
        │     GRID        │
        └─────────────────┘
                 │
                 ▼
        ┌─────────────────┐──── 33
        │ SELECT HALFTONE │
        │    PATTERN      │
        └─────────────────┘
                 │
                 ▼
        ┌─────────────────┐──── 34
        │ CONVERT PIXEL   │
        │ DATA TO HALFTONE│
        │     DATA        │
        └─────────────────┘
                 │
                 ▼
        ┌─────────────────┐
        │ PRINT COPIES OF │
        │     IMAGE       │──── 35
        └─────────────────┘
```

FIGURE 3

40 → INPUT PIXEL DATA INCLUDING COLOUR AND TONE INFORMATION

41 → REPEAT FOR EACH COLOUR OR BLACK SCREEN REQUIRED

42 → COMPARE PIXEL DATA WITH APPROPRIATE THRESHOLD MATRIX

43 → RECORD HALFTONE DATA FOR PARTICULAR SCREEN

44 → NEXT SCREEN ?
    Y
    N

45 → OUTPUT PRINT DATA FOR COLOUR AND BLACK HALFTONE SCREENS

FIGURE 4

FIGURE 5a

FIGURE 5b
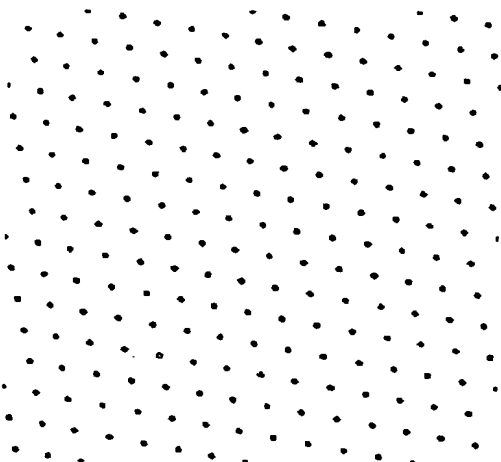
FIGURE 5c
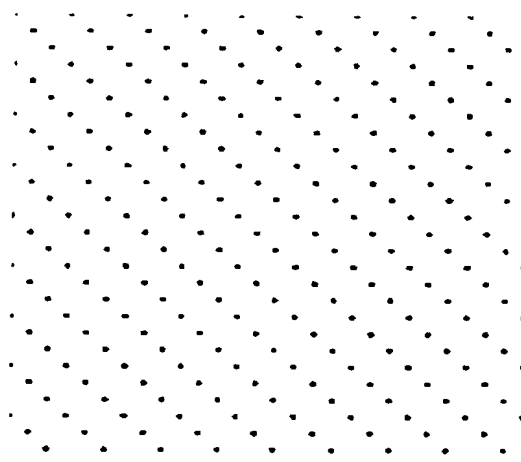
FIGURE 5d
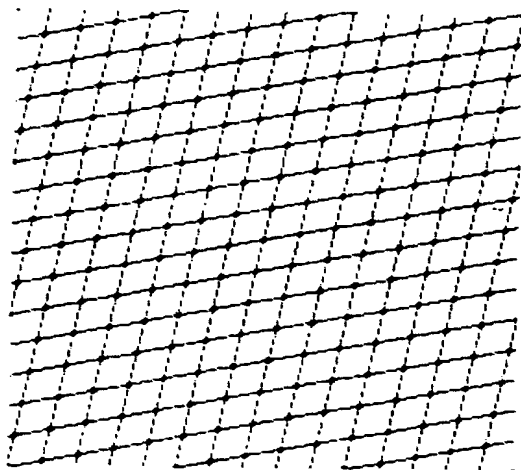
FIGURE 6a
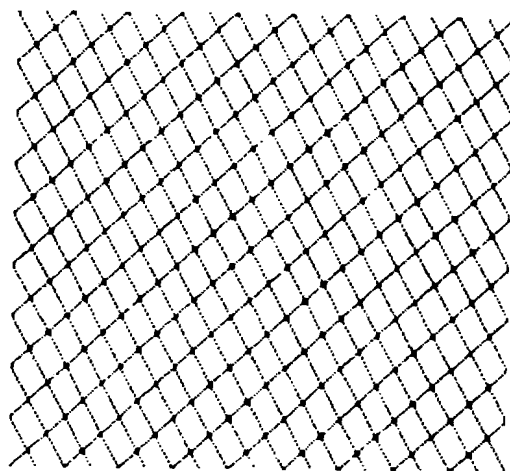
FIGURE 6b
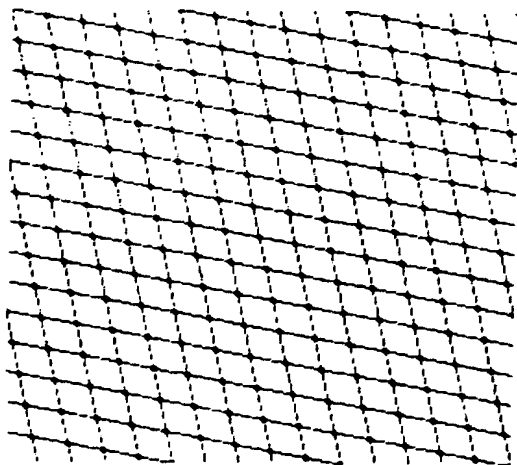
FIGURE 6c
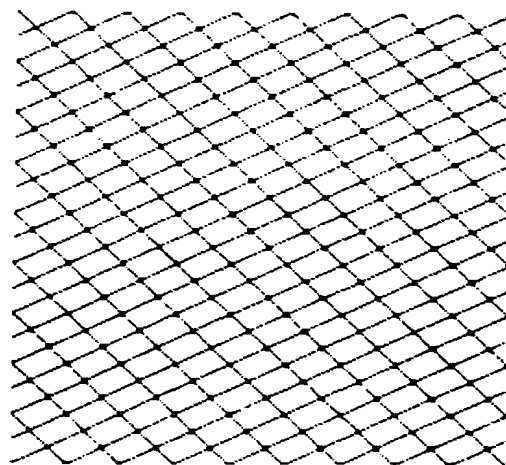
FIGURE 6d
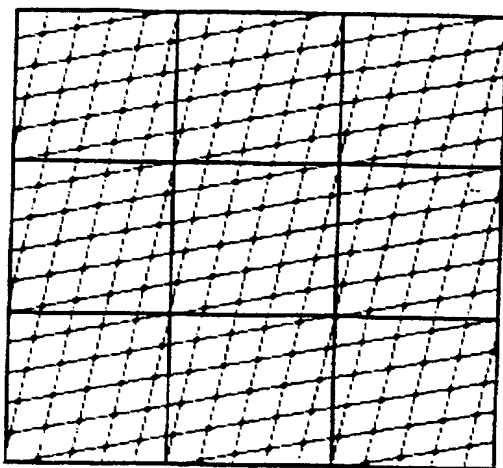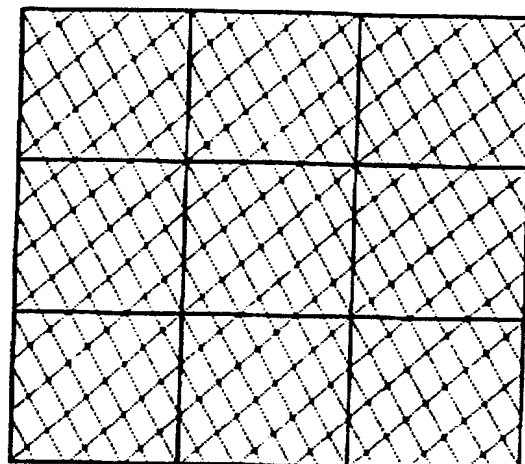
FIGURE 7a   **FIGURE 7b**
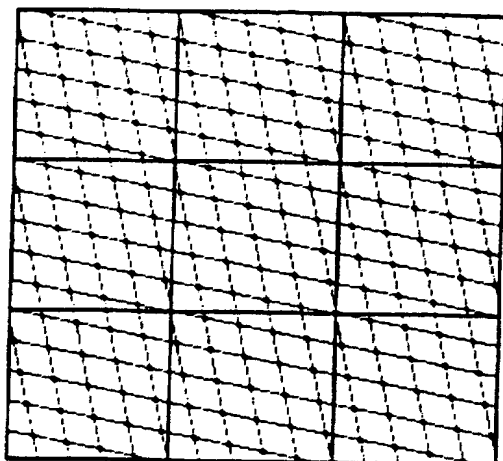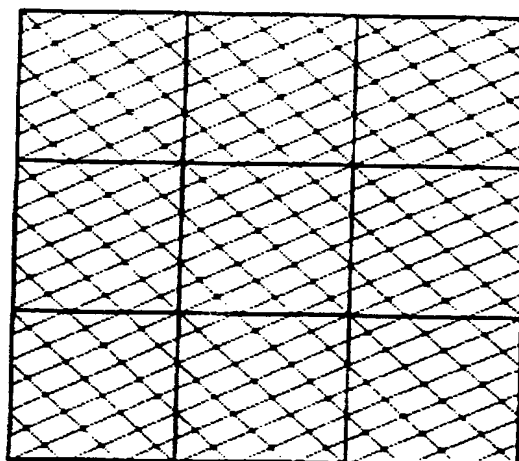
FIGURE 7c   **FIGURE 7d**
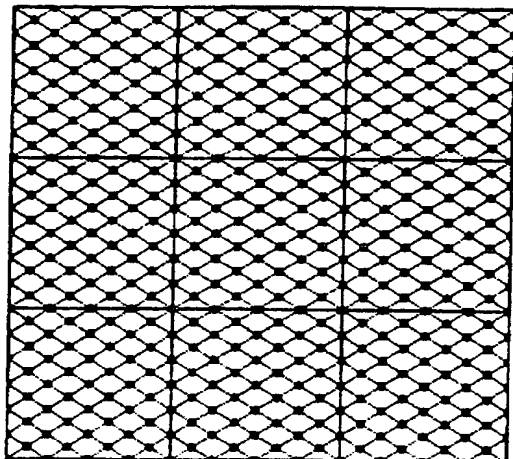
FIGURE 8a
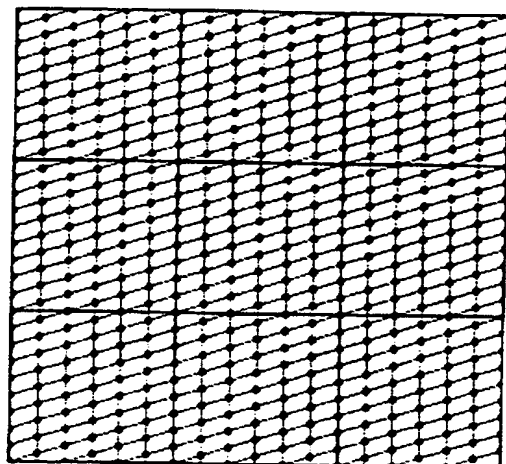
FIGURE 8b
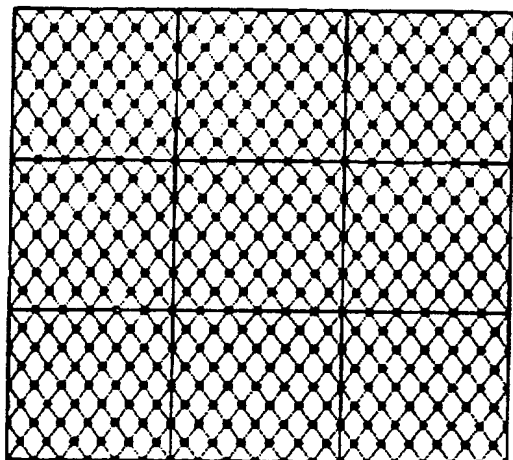
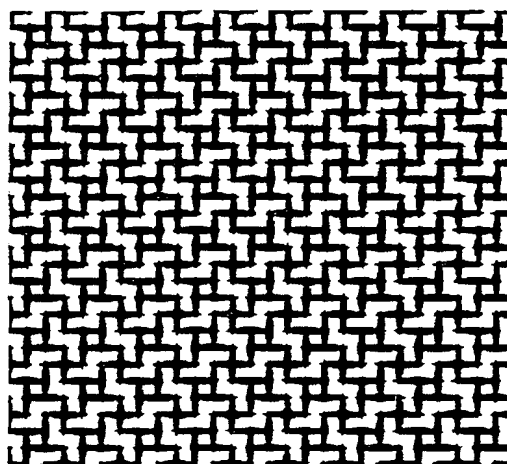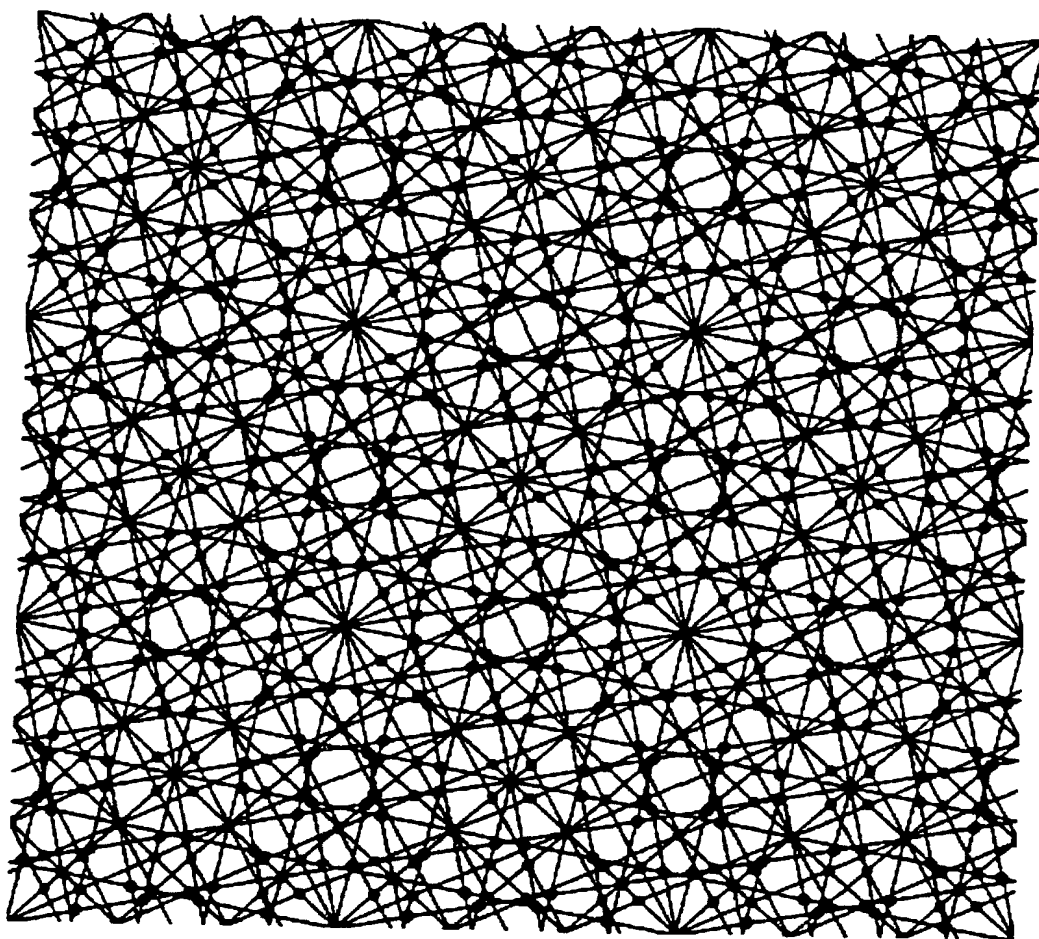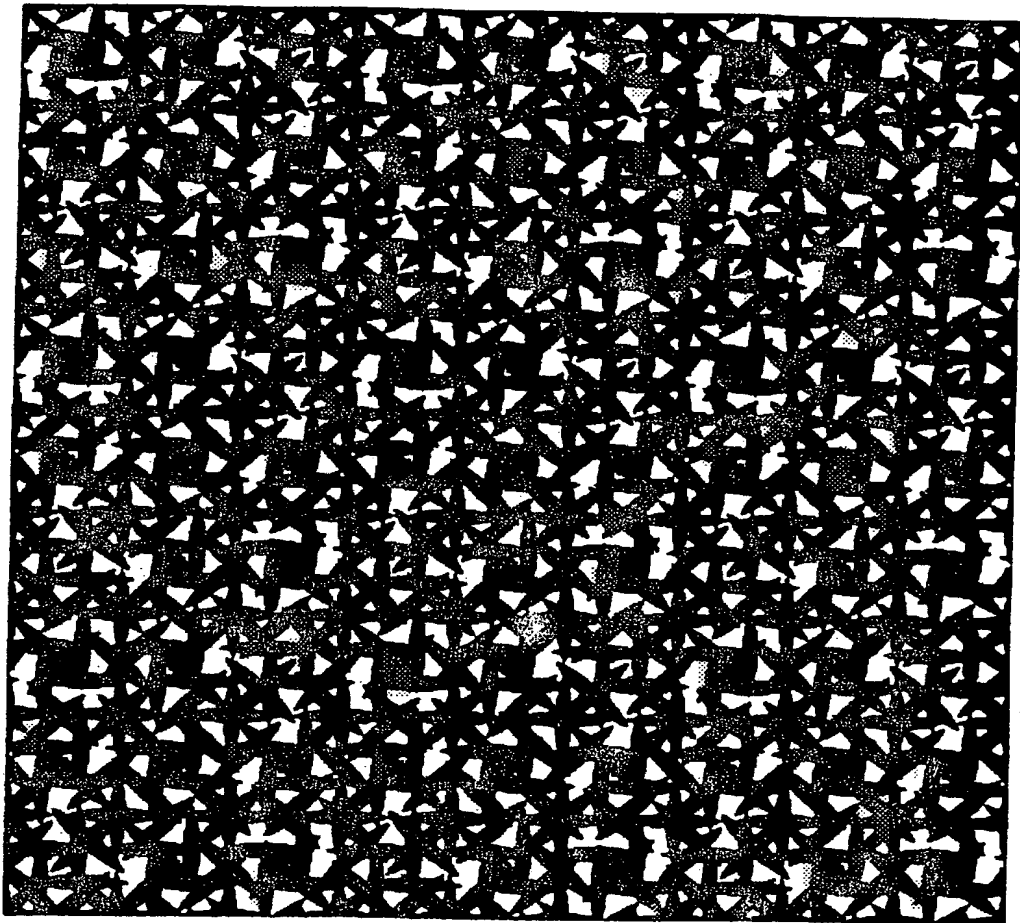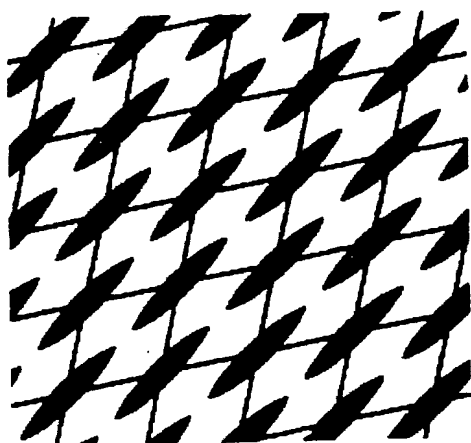**FIGURE 8c**
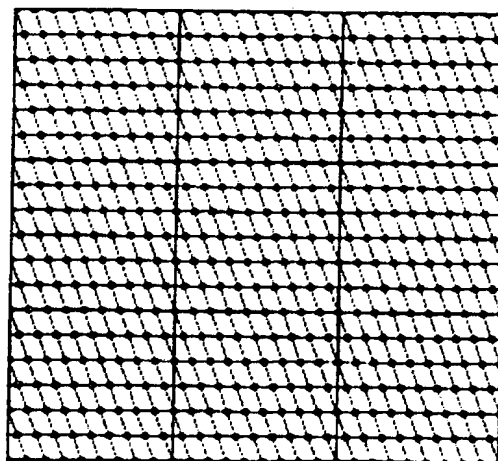
FIGURE 8d
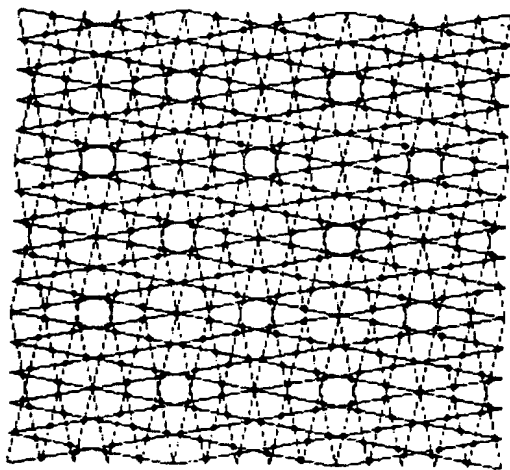
FIGURE 9a
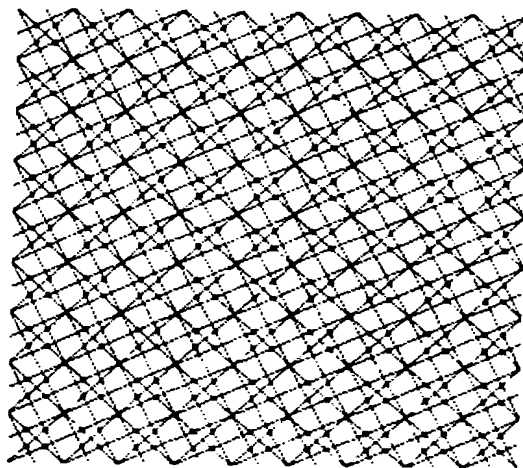
FIGURE 9b
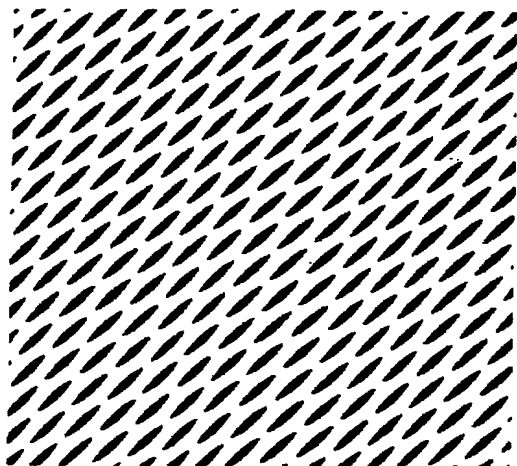
FIGURE 10a
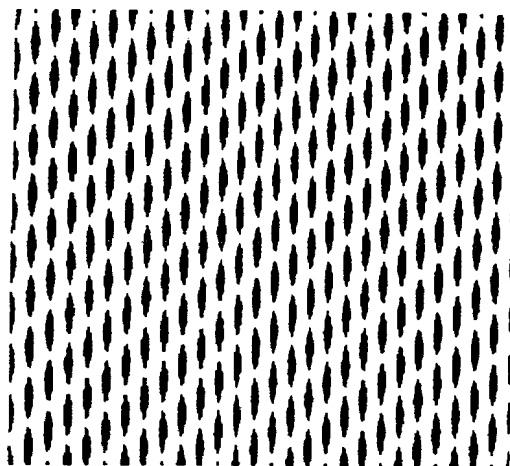
FIGURE 10b
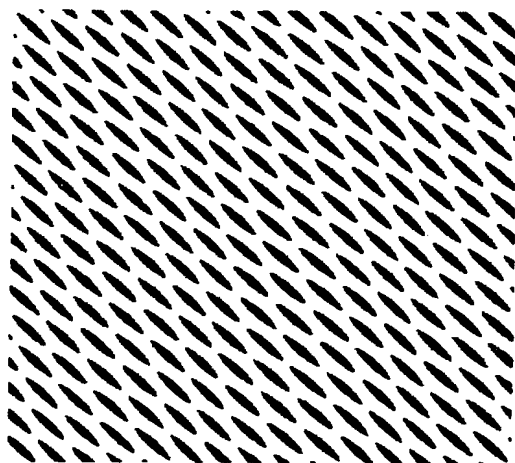
FIGURE 10c
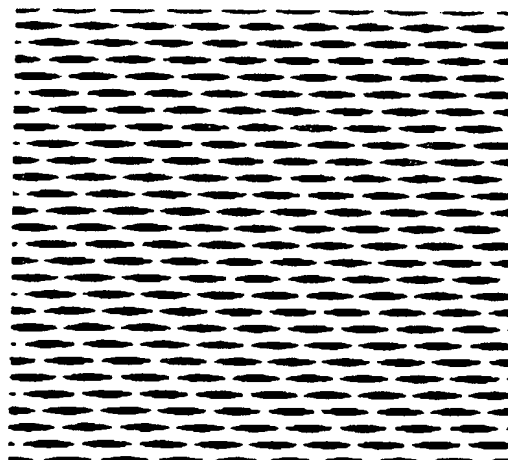
FIGURE 10d
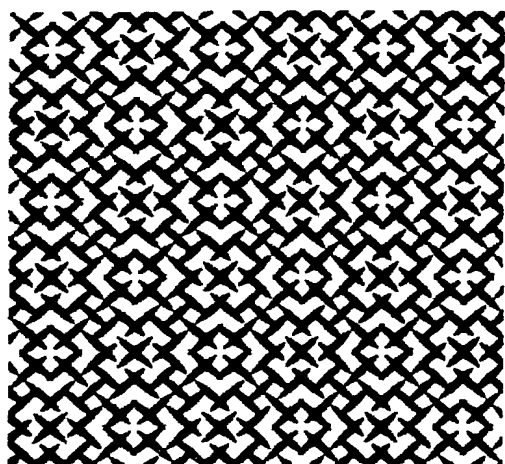
FIGURE 11a   **FIGURE 11b**

FIGURE 12

FIGURE 13

FIGURE 14a
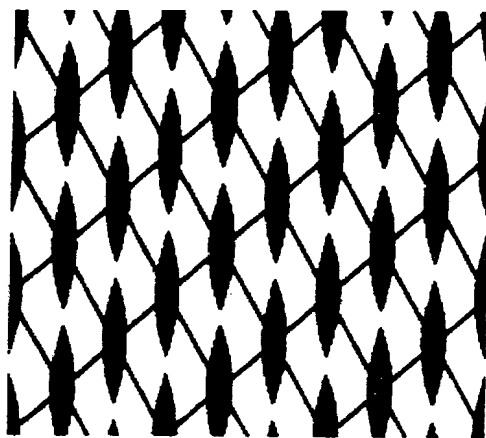
FIGURE 14b
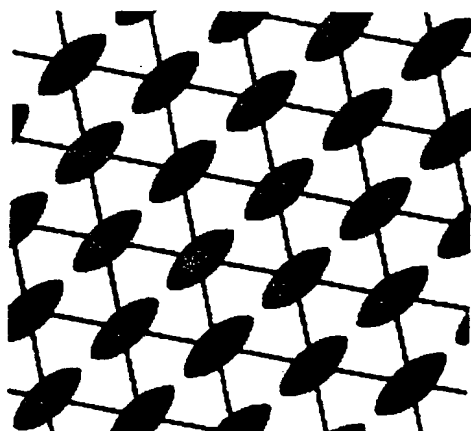
FIGURE 14c
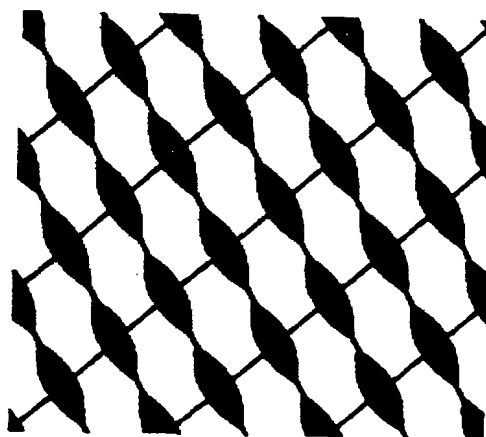
FIGURE 14d
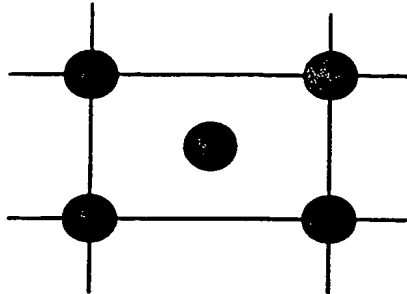
FIGURE 15
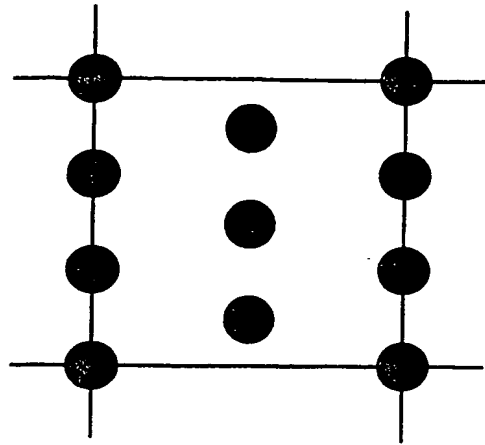
FIGURE 16

4	16	28	33	26	11	3
12	24	20	7	19	23	15
31	35	8	1	6	34	30
17	25	21	9	18	22	10
5	13	27	32	29	14	2

FIGURE 17

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7   H04N1/52

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7   H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 1 355 540 A (HELL RUDOLF DR ING GMBH) 5 June 1974 (1974-06-05) page 1, line 35 - line 48 page 2, line 4 - line 59; figures 1-6 ---	1-21
A	US 5 687 005 A (FISCHER GERHARD ET AL) 11 November 1997 (1997-11-11) abstract; figures 2-4 column 1, line 46 -column 2, line 16 ---	1-21
A	US 4 149 194 A (HOLLADAY THOMAS M) 10 April 1979 (1979-04-10) abstract; figure 1 column 1, line 55 - line 65 ---	1-21
A	EP 0 748 109 A (BAYER AG) 11 December 1996 (1996-12-11) abstract; figures 1-16 ---	1-21

-/--

[X] Further documents are listed in the continuation of box C.   [X] Patent family members are listed in annex.

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"O" document referring to an oral disclosure, use, exhibition or other means
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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 July 2000	08/08/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31–70) 340–2040, Tx. 31 651 epo nl, Fax: (+31–70) 340–3016	Kassow, H

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INTERNATIONAL SEARCH REPORT

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 805 586 A (DAINIPPON SCREEN MFG) 5 November 1997 (1997-11-05) abstract; figures 1-28 ---	1-21
A	US 5 455 682 A (IKUTA KUNIO) 3 October 1995 (1995-10-03) abstract; figures 1-18 ---	1-21
A	US 5 381 247 A (HAINS CHARLES M) 10 January 1995 (1995-01-10) abstract; figures 4-9 -----	1-21

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

Int. .ational Application No

PCT/NZ 00/00029

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EP 0748109	A	11-12-1996	US DE DE DE EP JP	5155599 A 9218864 U 69219527 D 69219527 T 0525520 A 5257268 A	13-10-1992 11-01-1996 12-06-1997 02-01-1998 03-02-1993 08-10-1993
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